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ALGORITHM AND PROCEDURES TO SOLUTION NONLINEAR DIFFERENTIAL EQUATIONS SYSTEM

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Extended abstract

For a dynamic system with more degree of freedom, as results from a finite element analysis of a mechanical mashed structure used in finite elements analysis, dynamical motion equations form a differential equations system

$$[M]\{\ddot{U}\}+[C]\{\dot{U}\}+[K]\{U\}=\{F(t)\},$$

where- [*M*], [*C*], [*K*] are mass matrix, dumping matrix and stiffness matrix, named *characteristic matrix* of system, - {*U*}, {*U*}, {*U*}, {*F*} are displacement, velocity, acceleration and external forces vectors, written in the global coordinates system. The unknown values {*U*} are time varying functions, {*U*}={*U(t)*}, and generally represent longitudinal, transversal and rotations displacements.

To determinate the values of unknowns there are some step by step methods, which integrate the motion equations at discrete time moments *t*, *t+Δt*, *t+2Δt,...,t+nΔt*, in considered interval. Recurrence relations determine the unknown values at the time step *i*, using the anterior values at steps *i*-1, *i*-2, *i*-3 etc. For example, Hubolt integration method [1]

$$\left(\frac{2}{h^2}[M]+\frac{11}{6h}[C]+[K]\right)\{U\}_i =$$

$$\{F\}_i+\left(\frac{5}{h^2}[M]+\frac{3}{h}[C]\right)\{U\}_{i-1}-\left(\frac{4}{h^2}[M]+\frac{3}{2h}[C]\right)\{U\}_{i-2}+\left(\frac{1}{h^2}[M]\frac{+}{3h}[C]\right)\{U\}_{i-3},$$

The elements of characteristic matrix of system, [*M*], [*C*], [*K*], according to the dynamic model, may be in three distinct situations within study time interval a) constants in time, b) time varying or c) depending of unknowns and their derivatives. In most general c) case, motion equations (1) are nonlinear differential second order equations, with unknown coefficients depending of unknowns, their derivatives and eventually the time:

$$[M]=[\Phi(u,\dot{u},\ddot{u},t)],[C]=[\Phi(u,\dot{u},\ddot{u},t)],[K]=[\Phi(u,\dot{u},\ddot{u},t)],\{F\}=\{\Phi(t)\}.$$

For numerical integration of this systems an algorithm are presented where the solution results after a successive iteration process.

REFERENCES

[1] Munteanu, M., *Numerical Methods in Mechanical Structure Dynamic. Laboratory and Course Support*, Transilvania University Brasov, 1998.